Fundamentals of Industrial Oil Hydraulics and Pneumatics
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Module01 Lecture02
Basics of Components, Symbols and Circuits

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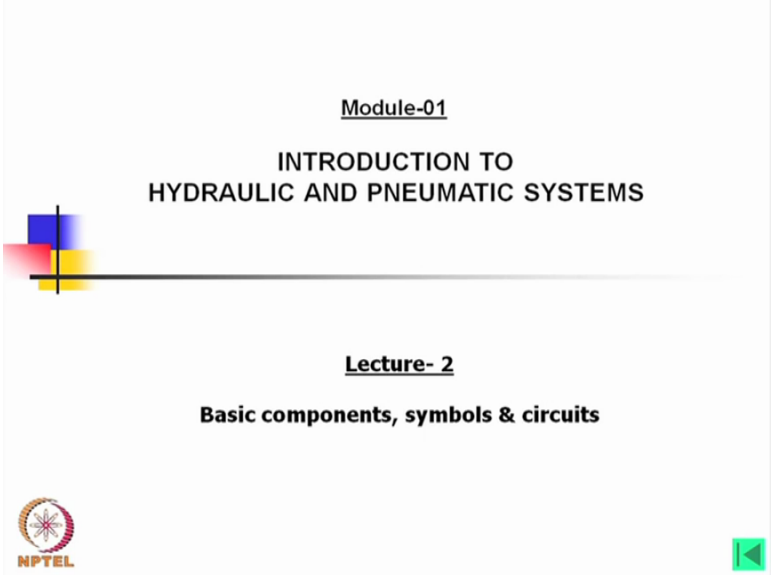

Now this is second lecture of module 1 which is introduction to hydraulic and Pneumatic Systems and in this lecture 2, we shall discuss about basics components, symbols and circuits.

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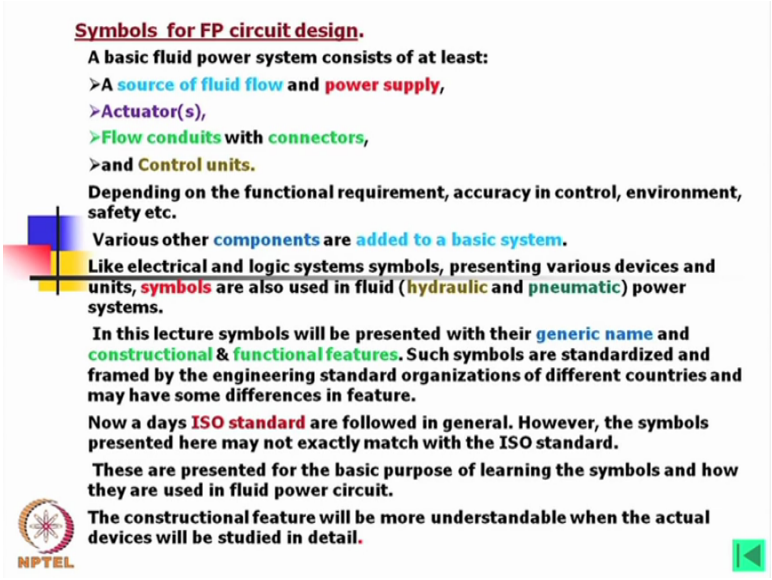

Symbols for fluid power circuit designs. What we have seen in the fluid power system that consist of at least a source of fluid flow and power supply, actuators, flow conduits with connectors and control units. Depending on the functional requirement, accuracy in control, environment, safety etcetera. Various other components are added to a basic system, like electrical and logic systems symbols, presenting various devices and units, symbols are also used in fluid that is hydraulic and pneumatic power systems. you know that for electrical circuit design we use the electrical symbols resistance, capacitance etcetera. In case of logic also different gates we used.

Similarly, in case of fluid power, we must use some symbols too for designing the circuit. In this lecture, symbols will be presented with their generic name and constructional and functional feature. Such symbols are standardized and framed by the engineering standard organizations of different countries and may have some differences in feature. Now a days ISO standard that is international standard organization are followed in general. However, the symbols presented here may not exactly match with the ISO standard. The problem is that ISO standard is not easily available to us. So may symbols what we have followed here, those are used in mainly the books and published work. These are presented for the basic purpose of learning the symbols and how they are used in fluid power circuit.

In if we follow the internets, if we look into the symbols, that should be available to us, but in many cases, you will not be able to download those symbols, although if you look into the catalogs for different manufacturers, you may find there, they have the components along with their symbols, which are ISO standard ISO symbols. So to learn that what we can do we can open a manufacturers catalog and we can see that what are the symbols, they have used. However, it is also possible to procure the ISO standards. Although those are very very expensive, but many companies, many manufacturers who are even using the fluid powers not may not be the manufacturers using the fluid powers. They might have their own standards and these ISO standards are based on the standards already we are being used in different countries. The constructional feature will be more understandable when the actual devices will be studied in details.

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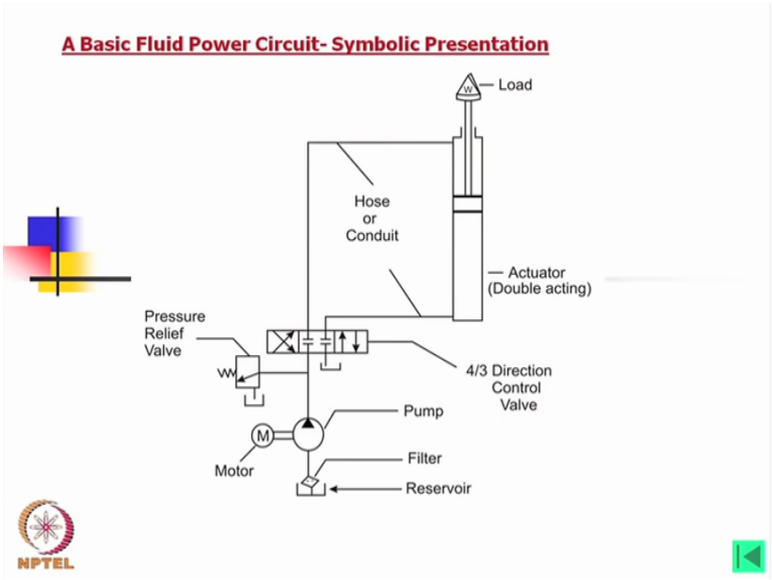

Now this circuit already we have studied. Here what we find that a load is being lifted by an double acting actuator and it is being operated by a directional control valve. Also a term is there 4 by 3 that I shall explain what it is. Then there is a pressure relief valve, there is a pump, the motor, filter and reservoir. Now actual components are different from this, but we present the whole system by a circuit and these are the here the symbols are main not the size, say for example, the pump must be much smaller than the reservoir, but what we see that as if reservoir is small, pump is the big. It is not like that the size we should use the minimum size, sometimes it is also possible, you can develop these symbols as an icon and then that can be imported to develop a system.

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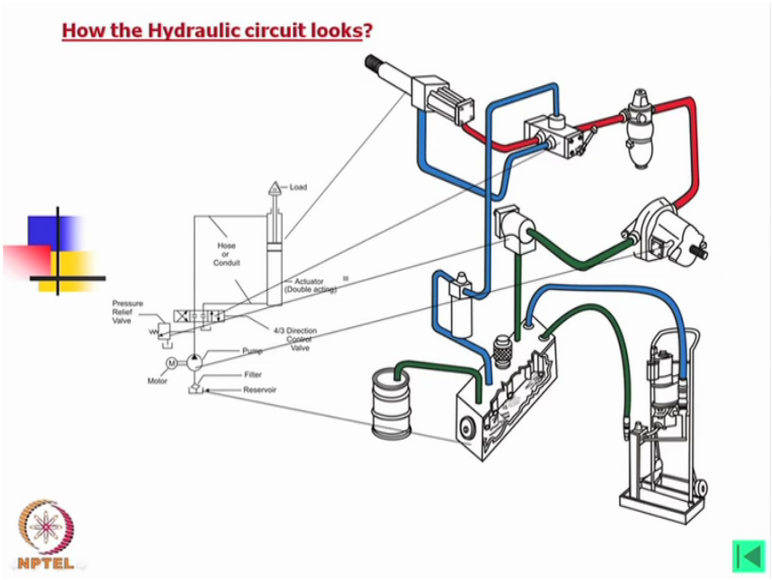

Now in the next slide what I have facen (())(7:07) presented how the hydraulic circuits looks. This is also again not the photographic view rather, this is a drawn by the computer graphics and here, what we see, say compare with this actuator. These actuator looks like this somewhat and then this is the valve directional control valve and then this is the pressure relief valve and this is the pump and this is the reservoir. However, this motor is not shown whereas they elaborate slightly elaborate the reservoir is shown and also, there is another system is shown, which is to put oil inside this. What we can do time to time, it may be after 6 months, it may be after 3 months depending on the use we can pump out the oil and filter it and again we can put inside to reduce the contamination, okay.

Now as well what we find here as if something is there. This is sometime the inline filter through which the oil is further filtered, before entering the actual system. This sometimes it is called high pressure filter, which is essential for servo mechanism or in some cases, where the proportional valve is used, but we do not know yet what is proportional valve we must have herd of servo valve, we must have heard of proportional valve also, but we do not know, we will learn that later and this is nothing but a barrel through which oil is being put inside.

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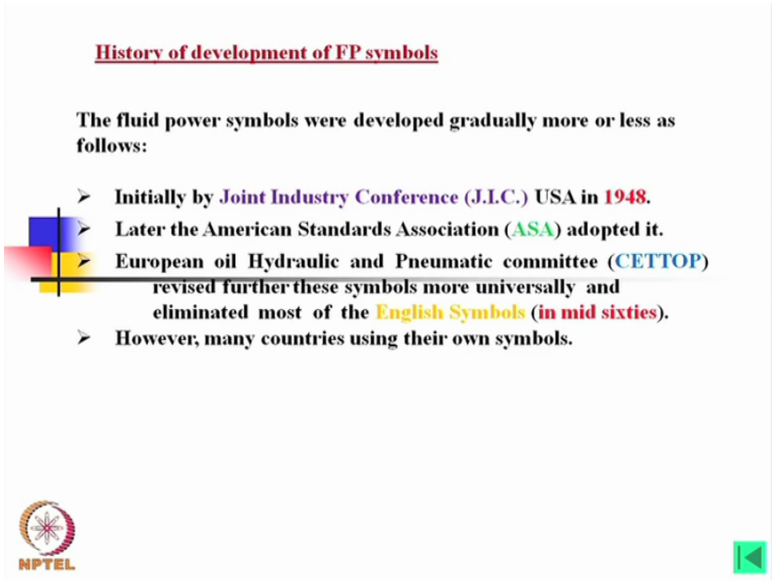

Now history of development of fluid power symbols. The fluid power symbols were developed in gradually more or less as follows. Initially by joint industry conference JIC USA in 1948. In first lecture as I told that after the second world war, when the many devices was developed fluranid based (())(9:40) some people, they thought that we must standardized this and then first they started standardizing those symbols by which we can design a circuit, at the same time research was going on also too for the theoretical backup of the devices.

Later the American standard association adopted it. European oil hydraulic and pneumatic committee CETTOP revised further these symbols more universally and eliminated most of the English symbols in mid-sixties. However, many countries using their own symbols. This is not very different, but you will find this is not also the same symbols. This means there will be some differences, say for example, in India what we follow at one point we standardized it or the many industries who are using those, they are also developed their own symbols.

Nowadays we can use the computer, we can develop the icon and we can use this, but at a point we had the templates, stencil, which we could use on the paper and we can draw the symbols for fluid power circuit design. Later ISO have revised the symbols for international use. Now it is recommended in every countries that we should follow the ISO Symbols and therefore, manufacturers they are now where they are describing their components using the ISO standards only.

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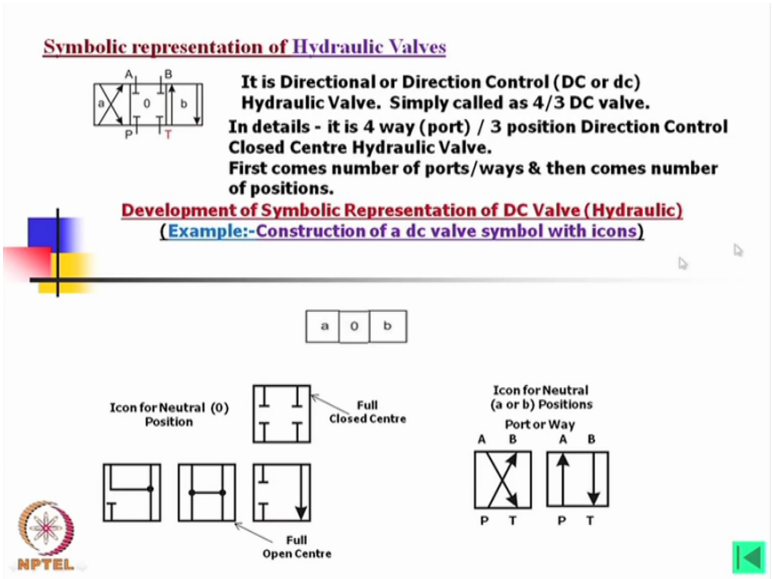

Now symbolic representation of a hydraulic valve. Now what we find that there are almost a square or may be a slightly rectangular 3 boxes put side by side and within one writturn zero and left side it is A, right side it is B and in this 3 compartment, there are some arrows or some symbols you can say are there. Now what it is? It is directional or direction control. In short form either capital DC or small d and c dc hydraulic valve. Simply called as 4 by 3 DC valve, but what is 4 by 3. In details, it is 4 way what we find A, B, P and T. there are 4 way or 4 port and then these three compartment means there is a 3 position. That means we kept we can get either this type of connection crossed connection or we can have straight connections or we can have these 4 ports are completely closed.

Now in details we should call it 4 ways 3 position direction control closed Centre hydraulic valve. What is closed centre, if we look into this; at this position that 0 position which is called neutral position. These 4 ports are closed. Now always when we are using 4 by 3 etcetera, the first comes the number of ports that is 4 means number of ports or ways and then comes number of positions. Now development of symbolic representation of DC valve that is direction control valve example, construction of DC valve symbol with icons. Now this is a simple icon where it is writturn 0.

Now we have another icon. Here it is A, these are not icon, just a box where we will represent the icon ultimate icon and then we put A here and then another we take a B and then we put it here. So these are not exact icons, but I would say that these are representing icons and then we can choose these 3, 2 even more icons and we can construct a valve for the directional control. Now in these 3 compartments middle one is the neutral and for neutral one we can choose say either this icon or this icon or this one or this one. Now this one is full closed centre that means all the ports are closed when it is neutral position. Contrary to that if I use this symbol, this will full open centre. Now this means that in middle there are A, B ports which can be connected to 2 sides of the actuator, one is input and another is output or vice versa for the reverse motion, whereas P indicates, it is connected to the pressure that is pump. This P actually indicates pressure not pump, but we can say it is connected to the pump and T is to the tank. This is for the drain okay.

Now if I again judge into these icons then look at these icons. This is that P is normally remain closed at neutral position whereas other 3 ports A, B and T are connected together. This means that if we imagine when it is connected to the actuator then at this position neutral positions, this load will come down oil will go to the tank, whereas this pump if it is running that will always remain ready with pressure. Definitely, if pump is closed that means delivery side is closed, it will develop a pressure beyond the pressure we are utilizing for the system and then this oil has to go through the pressure relief valve, question is that why we are keeping this pump ready? Why we are running the pump when the load is not being lifted? Actually in many cases, we need this actuation system very often that means on and off load is being lifted again coming the again being lifted and in that occasion, it is better to keep this oil ready for the operation and it is beneficial than starting the pump and again between (()(18:28) the load. It will take more time without much saving the energy okay.

Now if I look into the 4th one what we find this path the supply path in one port and the pressure path is closed at neutral whereas, the other one is connected 2 ports are connected. In that case we can imagine the when we put into the neutral automatic the load will come down if we look into our the initial circuit which we have already studied. Now if I consider the icon for A and B then it is like that pressure port is connected to B, in this case the left one and the port A is connected to tank that means the supply is going to B port and oil from A port is coming to the tank. Now A, B this does not mean that one has to connect and connected the large end of the piston and other is the rod end (())(19:54) of the piston, it does not mean anyone can be connect the any side, but definitely both are not connected to the one side.

Now if we choose this one then we have to choose the other one, which is straight connection that is pressure port to A and B port to tank. Now if we use this as a B and if we use this one as a A and say this one as a O, then we should call this one 4 by 3 position directional control open centre valve hydraulic valve. Now one thing I would like to mention that pneumatic valve also will look more or less same, but there is some other symbols is added to this to understand that what is pneumatic which one is pneumatic valve and which one is hydraulic valve.

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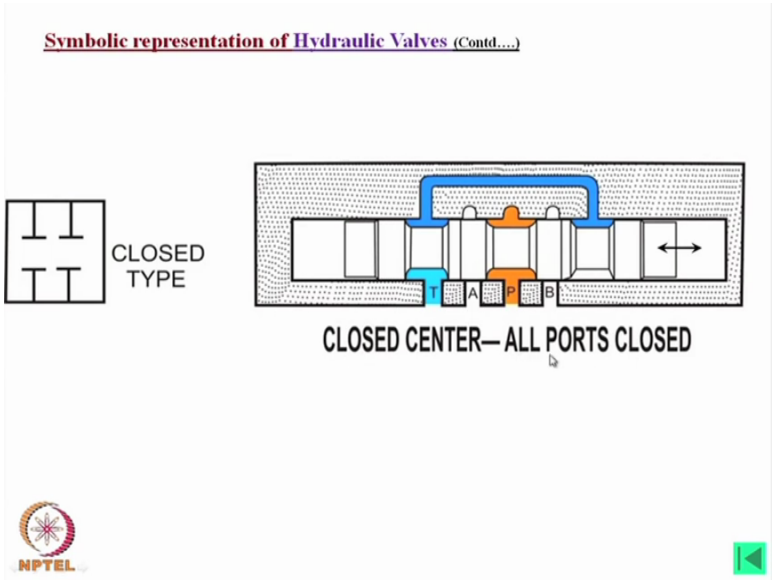

So we are now only discussing on the hydraulic valves. Now if I look into a details of this valve. How it looks like? Now what is this one, this is a spool from this point to this point it is a spool. Now this is a circular one, this is a cylindrical one as you find this is a the stem is of lower diameter than this one, again is upto this whole and again it is lowered again it is

upto this whole and then lowered and these two side may be cylindrical or may be flat type. Now there will be some connection by which we can move this spool this way or that way. Now how it is connected look into this. This is P pressure port. It is connected to the pump and then oil is coming over here, but oil cannot go any side at this position of this valve, which is the neutral position.

Similarly this port B and A are also closed as well as this T is closed in a sense that this has no connection with, it has connection to the tank, but it has no connection with the other ports. Now if we move in this way then say right one then P will be connected to B and you will find A will be connected to tank. Similarly if we push in these directions, then P will be connected to A and B will be connected to this path, through this it will go to the tank. So this is the construction of closed center valve all ports are closed at neutral positions.

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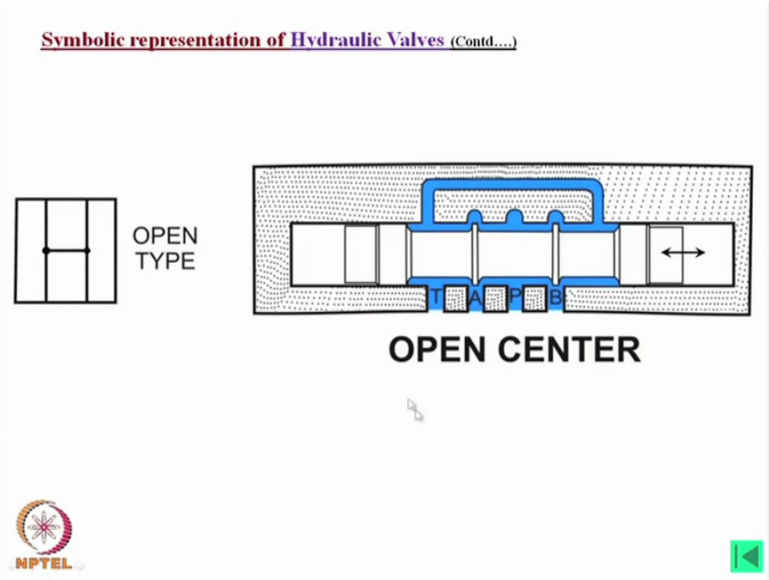

Now if we consider the open center, you can see just this spool is changed. In this case, the P is connected to the all ports at this neutral position. Now if I move this in the right or directions then P will be connected to B and A will be connected to tank and if I move in the other direction, it will be reverse.

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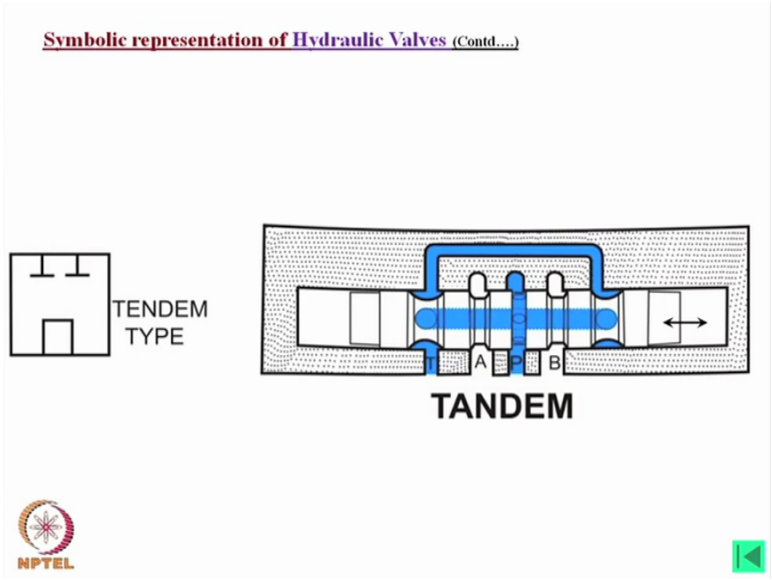

Now this is called tandem center. What is in tandem centre? In tandem center that oil at neutral position is going to the tank directly, whereas these two ports are closed, right. Now if we move in the right directions then P will be connected to B, but look at this. This path will be closed and then A will be connected to T and it will be reverse in if we move in the opposite directions. Now if I discuss over the closed center open center defiantly one is use to other for some benefits, I will discuss that in this section as well as later in more rigorously.

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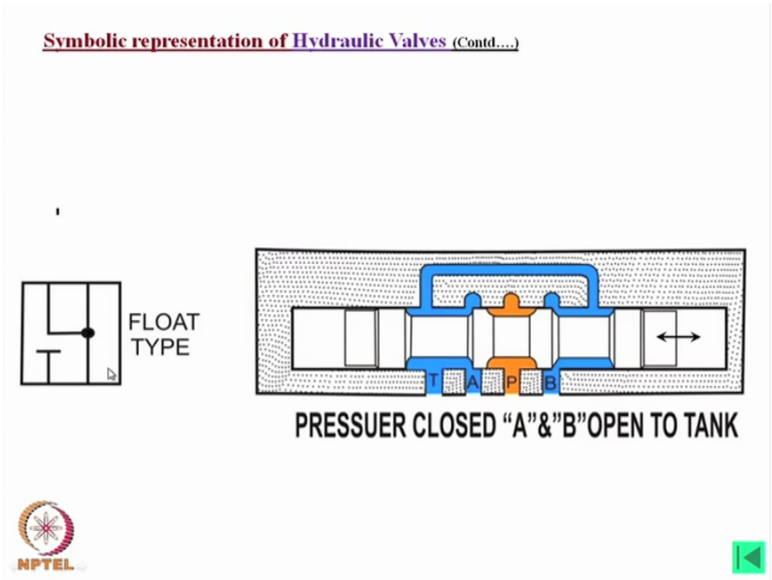

However, before that we should consider the other type valves. There are other options also. In this case, as we see that at neutral position P is closed, but all other are connected tank. Now as you move in this directions P will be connected to B, A will be A will still remain

connected to tank, whereas move if you move in the opposite directions A will be connected to pressure port and B will still remain connected to the tank, okay.

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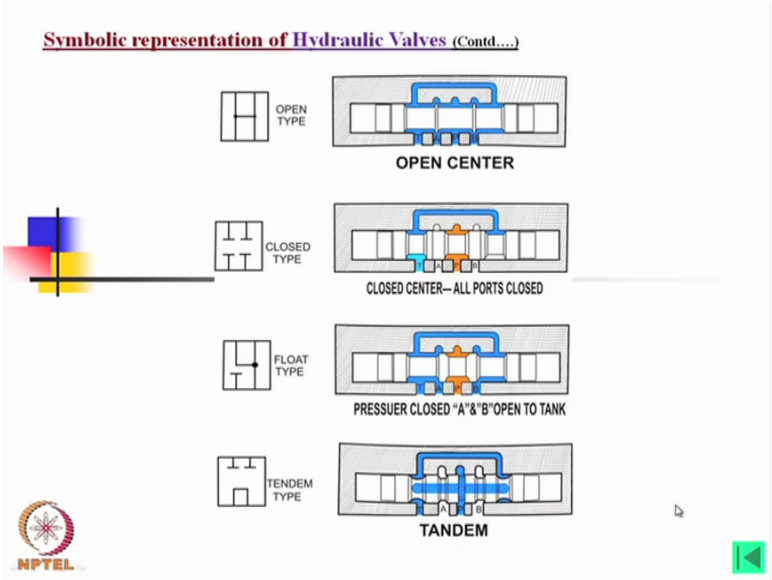

Now if I put all together then open center is useful for energy saving that means oil not if we discharge the oil through the relief valve at pressurized conditions, too much heat will be generated. So all the power will be lossed through the heat energy. If we use the open center definitely this pump oil will not be pressurized and it will be only circulate, it will go to the tank. So oil will remain cooled and there will be less power loss. Definitely, it is benefitted, but why then we go for other valves, the reason is that. In this case, the oil which is being pumped is not ready with pressure. So this system we normally we will use where we may not need very quick action as well as these operations is being done after certain time intervals. In comparison to that if we go for the closed center type valve. In that case, oil is always ready and whatever the condition of the system after an operation that will remain as it is, say for example, load is being lifted half the way.

Now we have put back the spool to the neutral positions. So the load will not come down, however there will be leakages. So it may come down slowly, but there are standardization of too. So general applications it might be say it might be allow to that one meter in a day, sorry whereas in military applications, you will find their specification is that may be 1 centimeter in a day. So depending on that accuracy of these valve is maintained and selected in that way and definitely for more accurate valve cost will increase.

Now similarly if I go to the tandem which is mostly used. A tandem is that we can keep the load position like that at the mid-way whereas; oil is being not through the relief valve when it is in neutral position. So energy is being saved. This means that we would say then when we need very quick action and intermediate position of the load, we shall go for closed type whereas, if we think of that we can use this saving the energy we will go for open type fully open type, but in most of the case you will find tandem type is might be the best one for common applications. However, the cost of tis tandem valve is more if you look into the spool, you can see inside the spool there is a hole and through this hole oil has to pass through this hole. There is no other way. So cost of this tandem valve is more in comparison to this closed type or fully open type. Now here we have all the mentioned that this can be moved we have not discussed how it can be moved, sorry.

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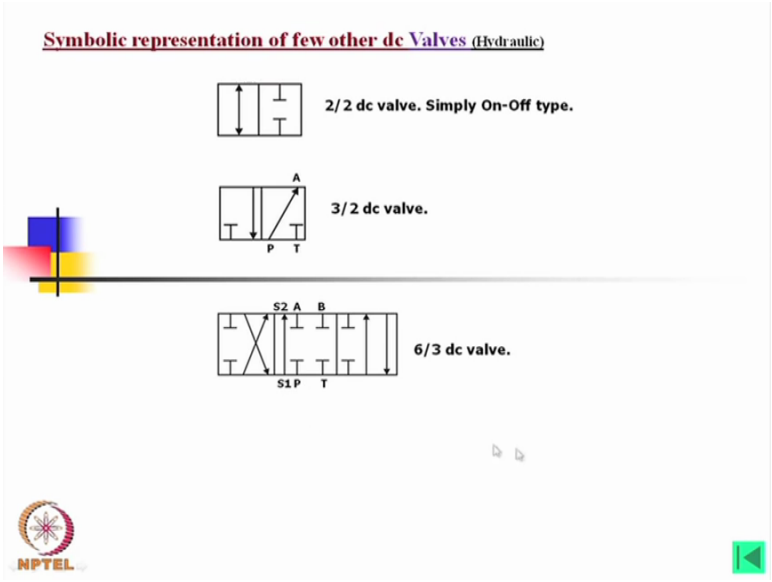

Now symbolic representation view under direction control valve. Now with these two icons what does it mean? Definitely this is 3 by 2 DC valve, 2 position and sorry two ports and two position. So these are used as a on-off type. There is no neutral positions either you put it here path is closed or you put it here. So this is simply on-off type. Now if I look into this what should be its name. So first we should call how many ways are there? How many ports are there? So definitely it is 3. Now as the 2 icons are there, 2 blocks are there. So this must be 3 by 2. So this is 3 by 2 DC valve. For this position the pressure port is closed and the system port is connected to the tank whereas, for this position tank position is closed and this oil is being supplied to the system or actuator.

Now looking into this what should be the name of this one. This is also direction control valve. Definitely there are 3 positions what we find, but how many ports are there? 6 ports are there. So name of this valve is 6 by 3 DC valve. Now what is A? It is a neutral position; I have writturn as S1 and S2. What is S1 and S2 that is perhaps, it is going to a some other system, but if you put in this position right position then, this S1, S2 will be disconnected and P will be connected to A and B will be connected to T and if I put into left side the cross connection will be there. That means P will be connected to B and A will be connected to T. So this valve (())(32:24) of 4 by 3 DC valve is used when this flow is going to some other system. This means that there is a external connection P to S1, okay pump is connected there.

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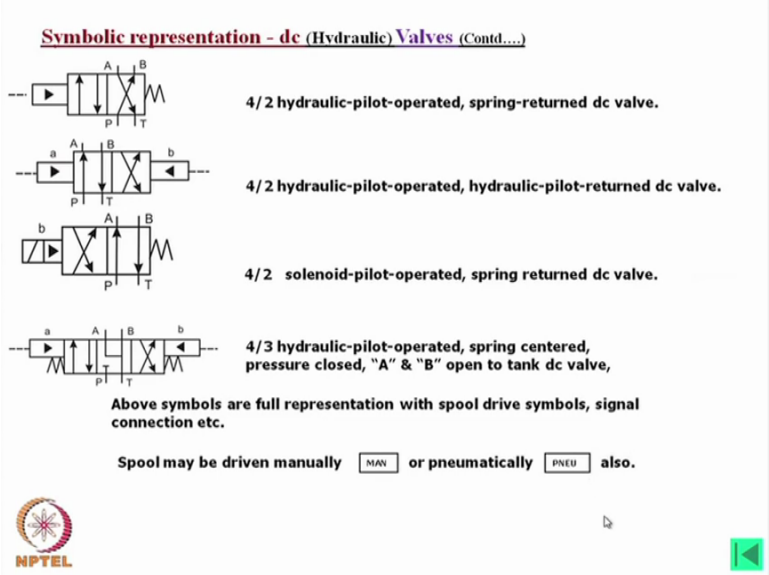

Now symbolic representation of DC valve we are still continuing. Now so far we have not discussed what is driving the spool and how the spool position is controlled. Controlled means at a certain position if you want to maintain the positions how it is being termed (()) (33:10). Now in this case what we will find away from these two icons, one side there is something like an, it is nothing but spring you can understand this is a symbol of the spring and left side, there is another rectangular block where is a arrow and there is one dotted lines.

Now this is 4 by 2 hydraulic pilot operated spring return DC valve. What it is that if I look into this? This is a, this symbol indicates this is being operated by an hydraulic. Now this line consider that some signal is coming there and it is this symbol is formed. Hydraulic signals is coming through this and as you hold (())(34:12) it is called pilot operated and then if we off this one, then automatically this spool will go back to its this position by a spring. So it a

spring return that means if this side is off, no signal is there, then it is working with this. When the signal will come then it will go here, okay.

Now this is another valve and what it might be we have seen this one. The first one, then what we find in the side b also more or less same symbols are there. Then this is 4 by 2 hydraulic pilot operated, hydraulic pilot return DC valve. This means that in both the side, there are the hydraulic operator, hydraulic actuator to operate this spool. If we actuate A, if this a signal then it will go to this position if there b signal, this will be in this position oh no it is might be the reverse if it is there then it is here, only if this signal is there. This is there. Now this detail can be understood from the looking into the actual valve.

Now this is another valve. In this case, what we find as if this and this is the same, the first one and this third one is the same, but instead of this signal line we find, there is another block with A inclined slash is there. Now name of this valve is that 4 by 2 solenoid pilot operated spring return DC valve. This is spring return, the first one. The third one is also spring return. So this feature is same, instead of the hydraulic signal in case of first one, here there is a solenoid that is electrical solenoid is there to operate this side. Now if I look into this. This is more complicated. This is definitely 3 positions, but there are 4 ports we find there are spring we find also, there is a hydraulic actuation, hydraulic pilot is there. So we can perhaps name it like that this is let us see, whether I am correct or not, we can say 4 by 3 hydraulic pilot operated spring return and this is partially open center DC valve.

Let us see, this is 4 by 3 hydraulic pilot operated spring centered. When we put the spring both the side we call it spring centered. When we put the spring one side we will call it spring return and a and b open to tank DC valve instead of partial open it is specified a, b open to this tank. Above symbols are full representation with spool drive symbols signal connection etcetera. So this means that when we select a valve for our circuit design, we should use these symbols. Now here I would like to mention if you look into the symbols of hydraulic systems, there are many many symbols, which is very very difficult to remember and neither you need to remember all these things, but the purpose of this study here is to that, if you at least go through few time with this valve, you will have some idea say looking into the construction of this valve one by one, we can perhaps understand another valve. How what it may be okay.

So basic purpose to learn these valves not to remember all these things. This will be available from either from this for the circuit designers in a company. They have their own valves

involves, you can go there you can call it or knowing it to the application of the valve, if you select the valve there you will find the symbol. Spool may be driven again manually or pneumatically. So in that case what we showed. So this is a hydraulic symbol. Similarly simply in many valve symbols you will find that instead of this arrow, it is put there and it is writturn man that is manually operation operated and if it put there and pneumatically valve is hydraulically hydraulic valve sorry and but the spool is being driven by pneumatic power.

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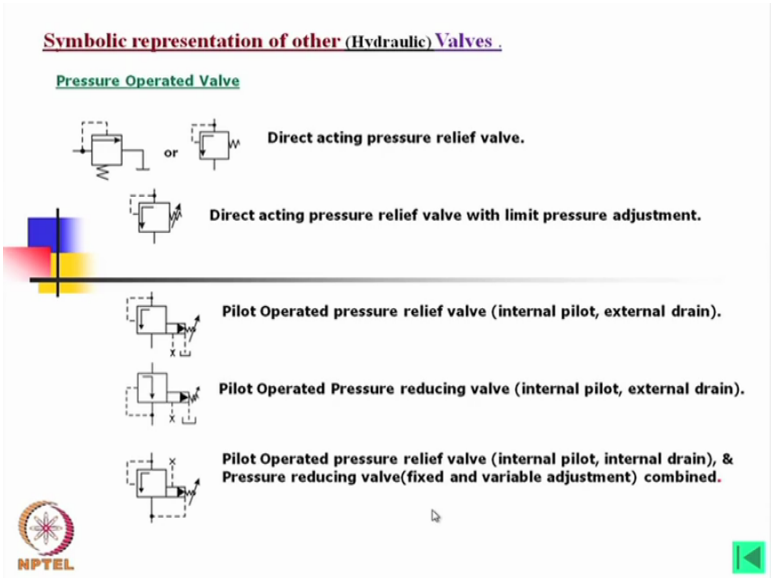

Now symbolic representation of other valves. So let us consider the most important the pressure operated valve. Now if we look into this symbol or this symbol, then this is a direct acting pressure relief valve. What it is say let us study this one. What we find this arrow is here and as if there is a end and this is drain and this is spring. That means spring is pushing this one. Now from here if a signal comes then, if this pressure rises above some limit then this will come here and this will be directly connected. So this is a direct acting pressure relief valve you can say. This is a direct acting means when the pressure directly pressurizing this poppet to open this one when it is crossing the pressure limit. It might be of this symbol in fact if we look into the pressure relief valve symbols, there are many other symbols are also used. Now ISO has standardized one and probably this one is the closed to the ISO one.

Now what is a difference here, we find in this spring direct acting pressure relief valve with limit pressure adjacent that means in this valve we can adjust this one. This spring strength to limit the pressure. Now if I look into these two valves. This is looking a like not much difference, but the above one is the pilot operated pressure relief valve internal pilot and external drain. In this case, pilot operated pressure reducing valve internal pilot, external

drain. Now what is pressure reducing and why it is called pressure relief valve? Now in this case what we find that this is connected to the supply line inline not the output line. So this signal is coming from the input side and this is used for pressure relief whereas, in this case if we find that the pilot line is connected to the output side, then definitely this is some regulating some pressure here.

Now apart from that this is again hydraulically and this drain is external, but here we have put some x on this line. These are not x actually, this is the closed port, but if this is opened then we can also generate external signal to operate this one. Do you understand my point? This is internally connected to the pressure line itself; however we can remove this and completely we can control through this external then we will connect through this, say for example, another system is sending a signal to operate this one. Now looking into these valve what might be the possible name of this one? Now this is pilot operated pressure relief valve internal pilot, internal drain in this case and pressure reducing valve as well fixed and variable adjustment. These are combined valve. There is a valve where we can regulate the pressure, we can reduce the pressure and it can be used as relief valve as well as the pressure reducing valve.

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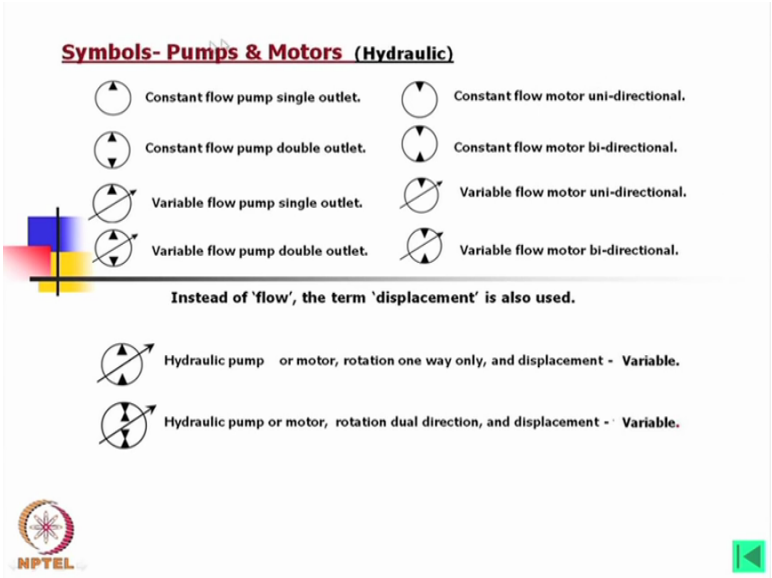

Now symbols for pumps and motors, first of all I will discuss about the rotary pumps. Now here I would like to mention that so far what I am discussing that is only a few example you will find, there are many many other symbols also, in fact you will be given few pages where the symbols are there that is from a book, I will mention later whereas, in case of this will be

available also if you go through the web lectures of this one and there it is given as a appendix.

Now coming to the pumps and motors. Now what we find here there is a circle and inside there is a arrow and this arrow is completely filled. It is looking black. Now filling this arrow has many. It is for hydraulic, this arrow is filled and in case of pneumatic, this kept an this is kept black okay, just a triangle is put there. However, this pneumatic pump is different rather it is a compressor, the symbol is different we will come later. So looking into this one circle and one arrow we should call it constant flow pump single output, okay.

Now if we have two arrow then constant flow pump double outlet. Now how it is possible? The pump is single outlet may be constructional feature inside same. Now this might be achieved if we rotate this in an opposite directions, this is one option. Another option is that this is fixed displacement, but inside there is such arrangement keeping the direction of rotation same (we) if we actuate that one. This flow will be from the other port okay. Now on the first one if we put an arrow, this indicates variable flow pump single outlet and if we put an arrow with the second one, this will be variable flow pump double outlet. Contrary to that the motors will be that arrow are toward the inside toward the center of this circle and if you see this name, this is a constant flow motor unidirectional. This is bidirectional that means here rotation we can if we change the rotation then the direction will change flow in to out and out to in like this.

Similarly this is the variable flow and this is the variable flow motor bidirectional. Now instead of flow, the term displacement is also used. We sometimes we use constant displacement or fixed displacement pump and variable displacement pump or variable displacement motor. Now this is in this symbol what we find as if there is a pump as well as motor. Now this is hydraulic pump definitely looking into this symbol again, it might be motor also. Now rotation one way only. What does it mean that suppose it is rotating in clockwise, if we rotate the shaft it will act as a pump? If we allow the oil to go in we can take the output from the shaft then it is motor, but the direction will remain same okay and what we find, this is a fixed displacement.

Now if we come to this one, this is hydraulic pump or motor, rotation dual directions and displacement fixed. What does it mean? In this case only direction of rotation is one direction say it is clockwise. In this case, we can use at clockwise as well as anticlockwise and for that rotation again it is either pump or motor depending on whether we are supplying the flow or

taking out the flow. Now if I add these two arrows then this will be variable displacement okay. So these are the few basic symbols of the pump and motors apart from these you will find many many other symbols are there depending on their operations, but most popular are what I have put 8 at the top, okay.

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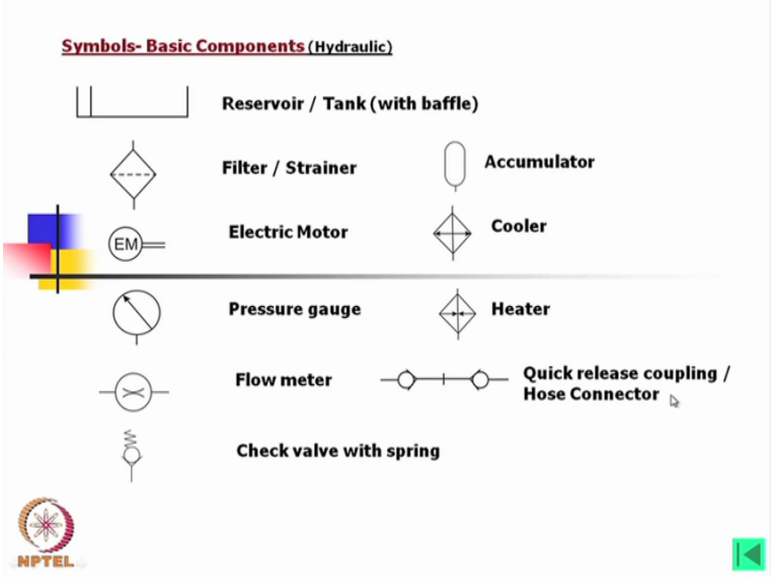

Now symbols for basic components. So this is a reservoir and we find another line here, which is baffle. What it is there? The oil main oil will come here or may be the return oil is coming here. Then this will go over this with some contamination will be can kept here as well as the foaming foam inside will be reduced. So baffle are was used. So that details you can learn from any book we shall not discuss much more on this how the tank is constructed.

Now this is a filter or strainer usually we need a when we put inside the tanks suction side we call it strainer and if we put it in the return side of the oil then we call it as filter. Now this is when we use this symbol, this is an electric motor, but as well we can write EM that is prime mover okay. Now this is the symbol for pressure gauge. This is the flow meter and this is the check valve with spring whereas, this is accumulator. Accumulator means you can store energy here, we will learn it separately in a lecture. Then this is cooler and this is heater. This symbols more or less same, but as you see these arrows is outside means heat is going out. So this I cooler and in this case, heat is going in. So this is heater and also sometimes this symbol is used in many case, you will find particularly for experimental setup we need a quick release coupling. This coupling if you just take it out then path will be closed to no oil will be go out even if it is pressurized oil inside you can simply open it to disconnect and

close it again it will be connected. When we will come to our lab we will show this what it looks like and this is a check valve.

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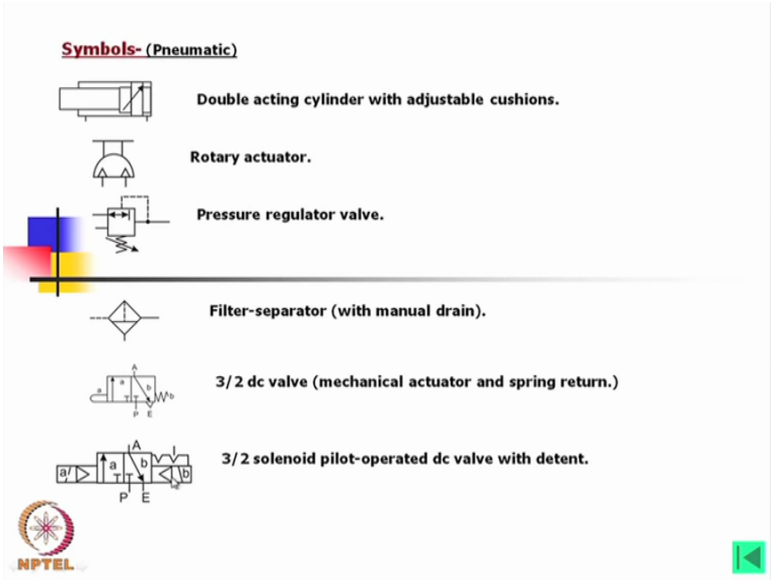

And then for pneumatics as you see, this is the double acting cylinder and this is the rotary actuator as you see this arrow are not filled in, but as well this is not a full circle also. This is actually rotary actuator means this is not compression rotary actuator motor. Now pressure regulator valve looks like this in case of pneumatics and pneumatic we need the filter separately. It is call filter separator. Now this is a direction control valve as you see 3 by 2 Dc valve, but looking into this arrow and this symbol, you can easily identify that this is a pneumatic not the hydraulic one. Similarly 3 by 2 solenoid pilot operated dc valve with detent looks like this.

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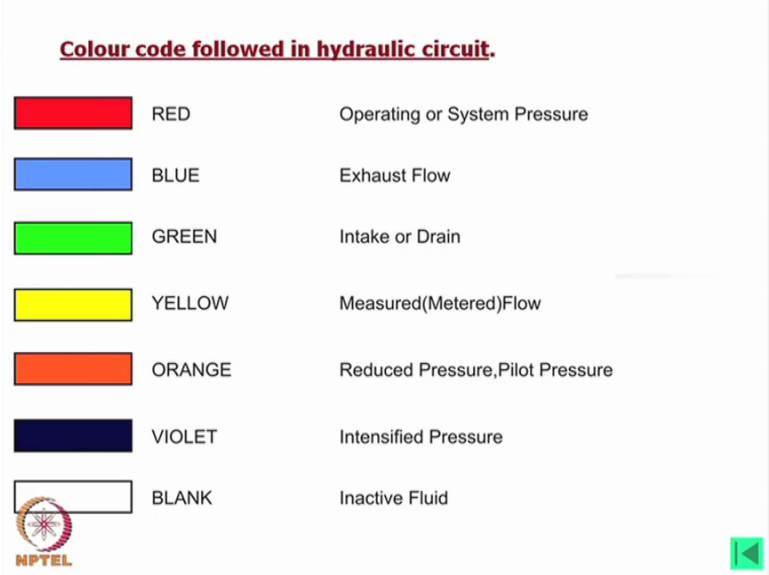

Now again I would like to mention usually while you are designing the circuit not the pneumatic but the hydraulic. These colors are used you may follow this if you well convergent with these colors then looking into the circuits if it is colored, you will be able to understand where pressurized oil where drain? Where leakage? Where controlled? Where is intensified pressure is there and there is inactive fluid as well if it is blank. However, in mostly very rarely we use this circuit, but in many cases you will find manufacturers while they are describing a circuit then they use this color. So this you can give it with you to understand circuit. This should be by the side of your hand to have a knowledge on what is what?

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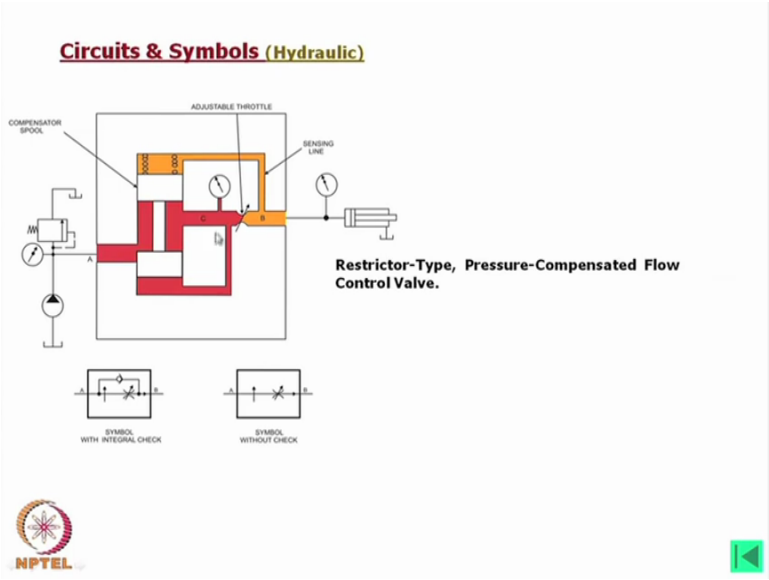

Now here with using such colors, now this is a valve as you can see. This is restrictor type, pressure compensated flow control valve. What is pressure compensated? In valve it is there that if pressure is increased then flow is reduced. Now this is we will study in details while we will come to the valve side, but as you see why I have shown it here? If you look into this valve, then these are symbolized like this. If it is with a check valve check valve means it is a to flow is in only one directions and this is a flow control valve, we will use this symbol if it is without this non return valve, then we will use this one. In fact this valve is without non return valve here and as you find this side is a pressure relief valve and pump is there and this is a pressure gauge and other side you find a cylinder is there and there is a pressure gauge and we can control the flow here and if there a pressure set automatically this flow will be controlled in some cases with the increase in flow sorry, with the increase in pressure the flow will automatically stopped.

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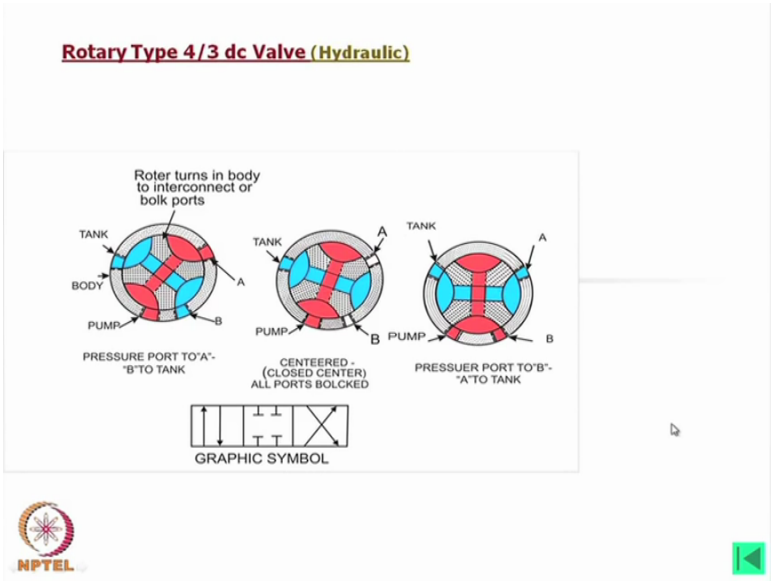

Now if we look into this. This is 4 by 3 dc valve, but this is a rotary type. These are not normally used, but still at one point this valve be can popular. In comparison to this the spool valve has better leakage property that means this leakage with that spool valve. Here it will be more leakage, but if this is easy to operate.

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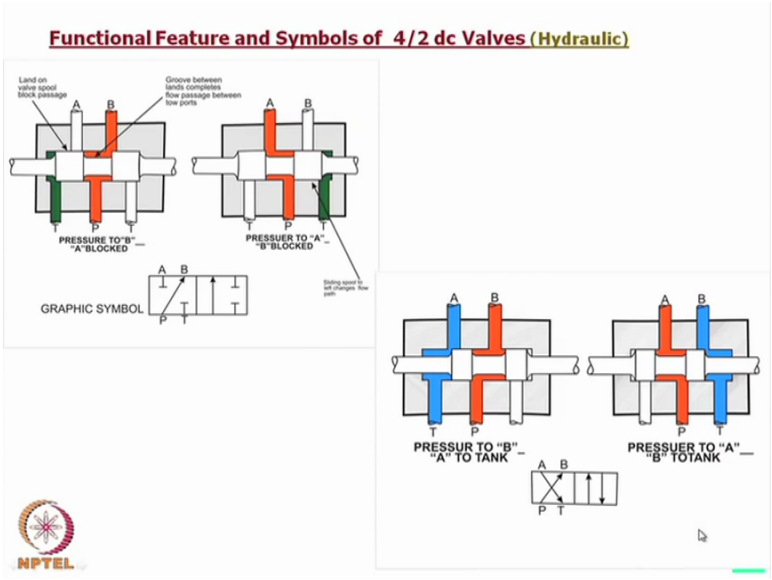

Now functional feature and symbols 4 by 2 dc valve as you look into these figures. This looks alike, but if you look into the symbol, these are different and if you study a little bit say in this case, the oil is going directly to B and then this is stopped and this is stopped whereas, oil going into A side then these two are stopped. In this case while oil is going to B still A is open to tank and it is vice versa.

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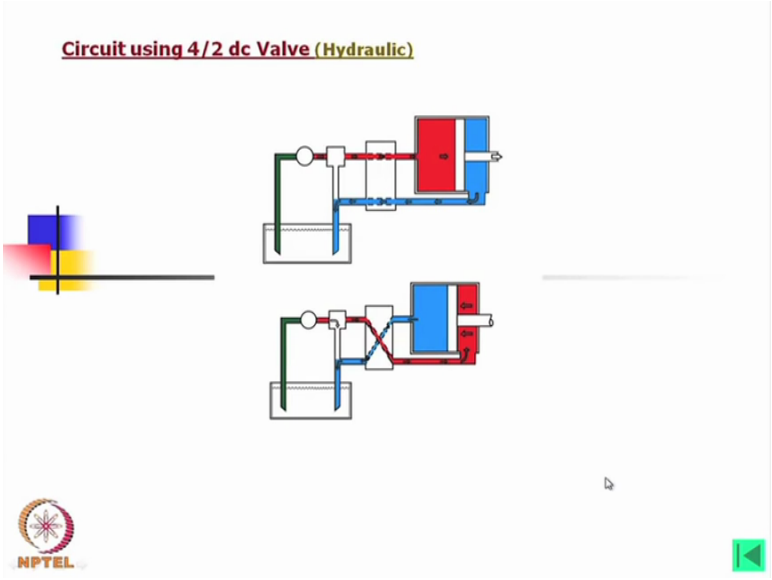

Now this is a very simple circuit is shown with a direction control valve. This is as if on-off not on-off type. This is two positions you can say either it is going straight or it is going in the opposite directions. So this circuit to understand the operations we can present it like this, but for general purpose we will use the some symbols.

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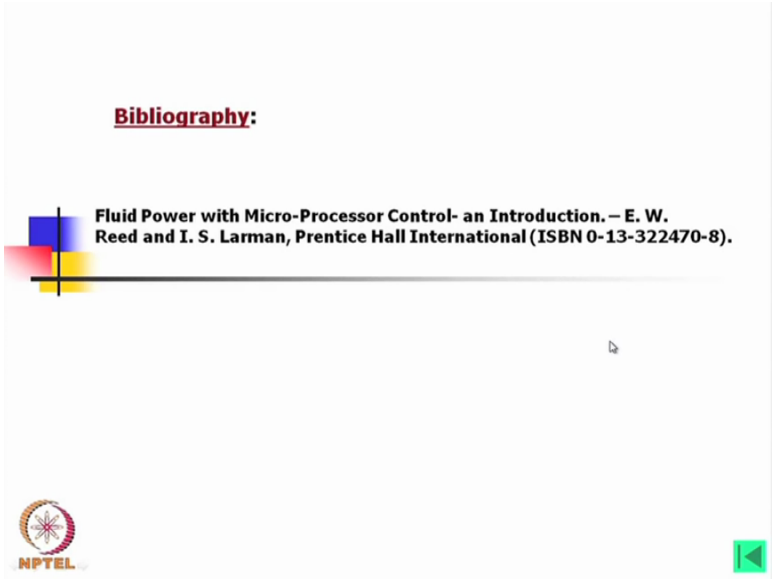

Now these symbols as I told that it is not from the ISO we have followed these fluid power and micro-processor control an introduction E.W. Reed and Larman. So this symbol will be available to you I shall give you later and thank you for listening.